



bioenergy2020+

Small-scale biomass heating vs. Air quality management

Final results of a project aiming at solving this conflict of interest:
***“New Stoves 2020 - domestic wood heating of the future;
measures for implementing state of the art technologies”***

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Head of Unit Combustion Systems

COMET

Competence Centers for
Excellent Technologies



Content

- Introduction
- Background
- Framework and concept of the project
- Experiences and main results of the project
- Outlook



Christoph Schmidl

Education:

- Environmental Management (Engineer)
- Chemical Engineering (M.Sc.)
- Technical Chemistry (Ph.D.)

Scientific/Professional Career

- Air quality: PM10 source apportionment for Austria (AQUELLA), European Background Sites (CARBOSOL) at Vienna University of Technology (VUT)
- Emission studies: Chemical characterisation of gaseous and particulate emissions from biomass combustion (VUT)
- Research and Development of biomass combustion systems (Bioenergy2020)
- Since 2010 R&D Management as Head of Unit Combustion Systems (BE2020)



Bioenergy2020+ Austrian Biomass Competence Centre - History

FOCUS: Energy from biomass

2002: National **Kplus** Biomass Centre of Competence
10/02-09/09 (financed from national **Kplus** program)



2006: Node of „Technopole“ Tulln
(financed in the frame of the Lower Austrian Technopole program)

2007: Business license as engineering company

2008: National **K1** Biomass Centre of Excellence
04/08-03/15 (financed from national **COMET** program)

2009: Merger of **Austrian Bioenergy Centre** and
RENET Austria to **BIOENERGY2020+**





Bioenergy2020+ Austrian Biomass Competence Centre - Overview

Locations

- 3 locations: **Graz (headquarters) – Güssing – Wieselburg**
- 2 other locations: **Tulln - Pinkafeld**

Staff

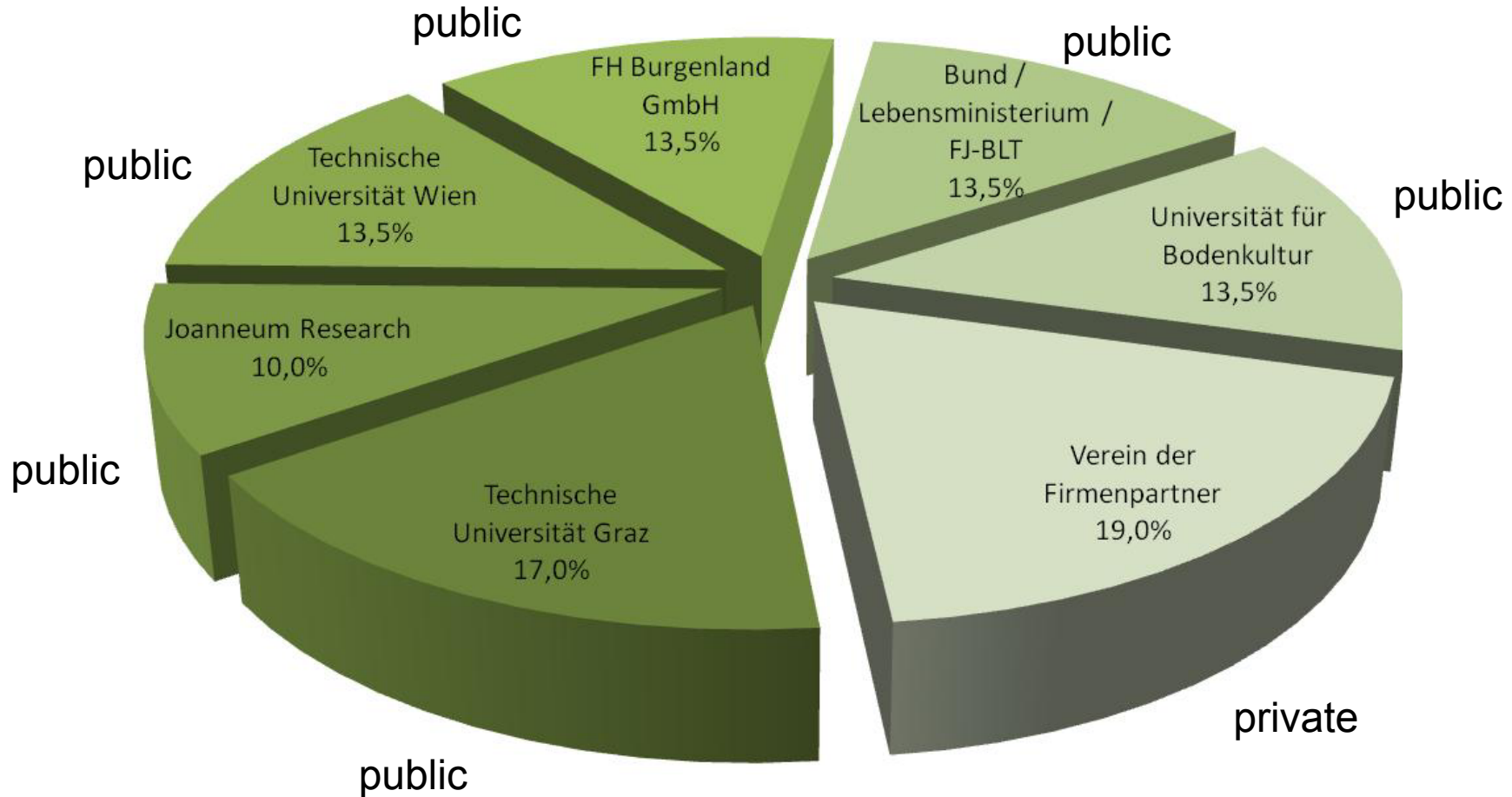
- currently: 100 employees (70 full-time equivalents)
- **(Wieselburg: 44 employees)**

Turn-over

- Total: ~7,5 million EUROS
- COMET: ~4,5 million EUROS from **K1** research **constant**
- nonCOMET: ~3 million EUROS from services **growing**

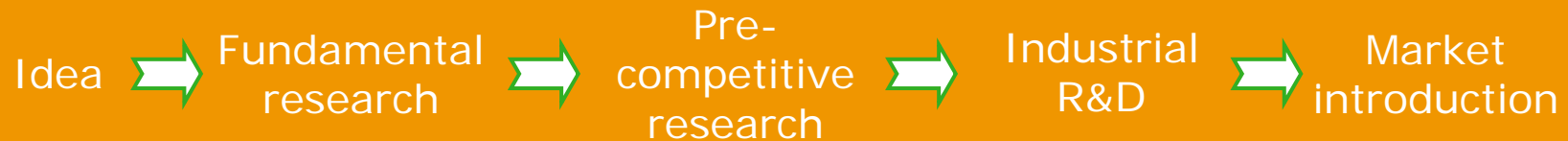


Bioenergy2020+ Austrian Biomass Competence Centre - Owners





Bioenergy2020+ Austrian Biomass Competence Centre - Services

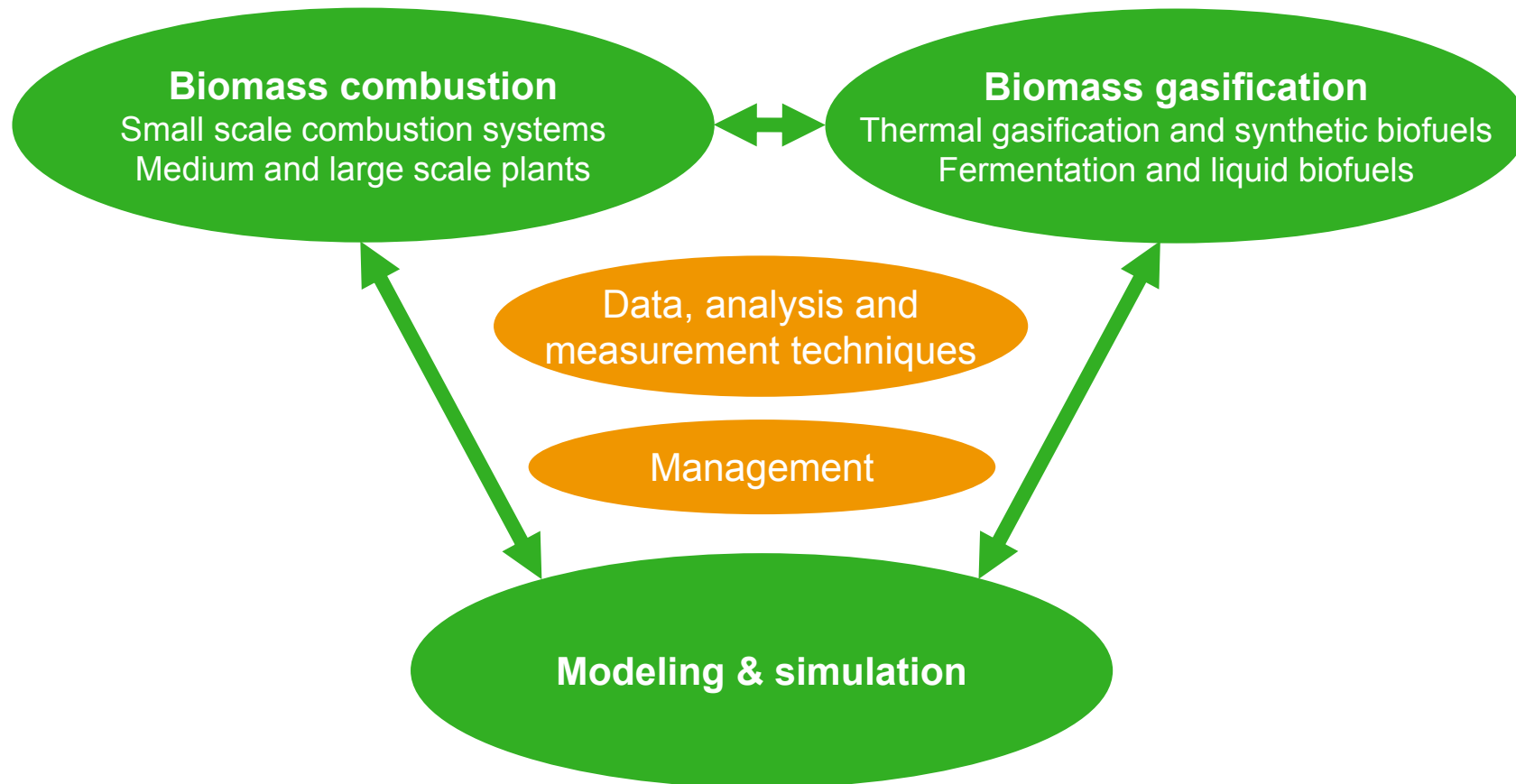


along the whole value chain

- **Cooperative research** (COMET and other programs: e.g. FP7)
- **Contract R&D** (Direct orders, funding programs)
- **Engineering** (Basic design, ..., Construction)
- **Consultancy** (Technologies, market, funding opportunities)
- **Trainings and seminars** (at BE2020 locations and in-house at customers)
- **Networking activities** (national and international)



Organisation of the research fields / areas





Fields of activities of Sub-Area small scale combustion systems (serial or close to serial production, up to ~500 kW)

- **Resources** and technical logistics
- **Tradable solid biomass fuels**
 - Characterization
 - Standardization
- **Zero emission combustion systems**
 - Stoves/Boiler development
 - System approach
 - Method development
- **Technical energy systems**
 - Small- and **micro-scale CHP**



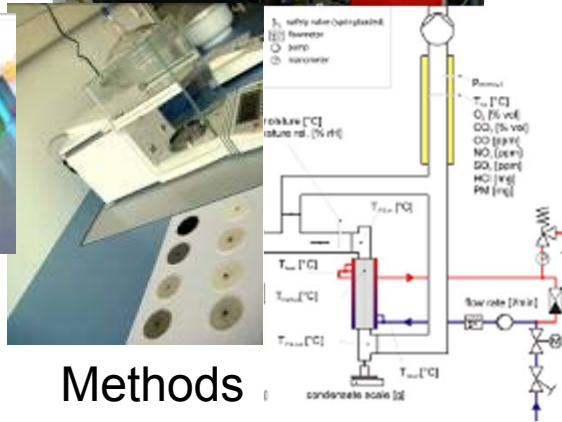
Experimental facilities / infrastructures



- 400 m² laboratory space
- 8 chimneys (11 in March)
- Up to 750 kW heat dissipation
- Test facilities: 1 - 220 kW
- Pre-installed primary circuits for heat dissipation
- Modern gas analysers



Laboratory equipment



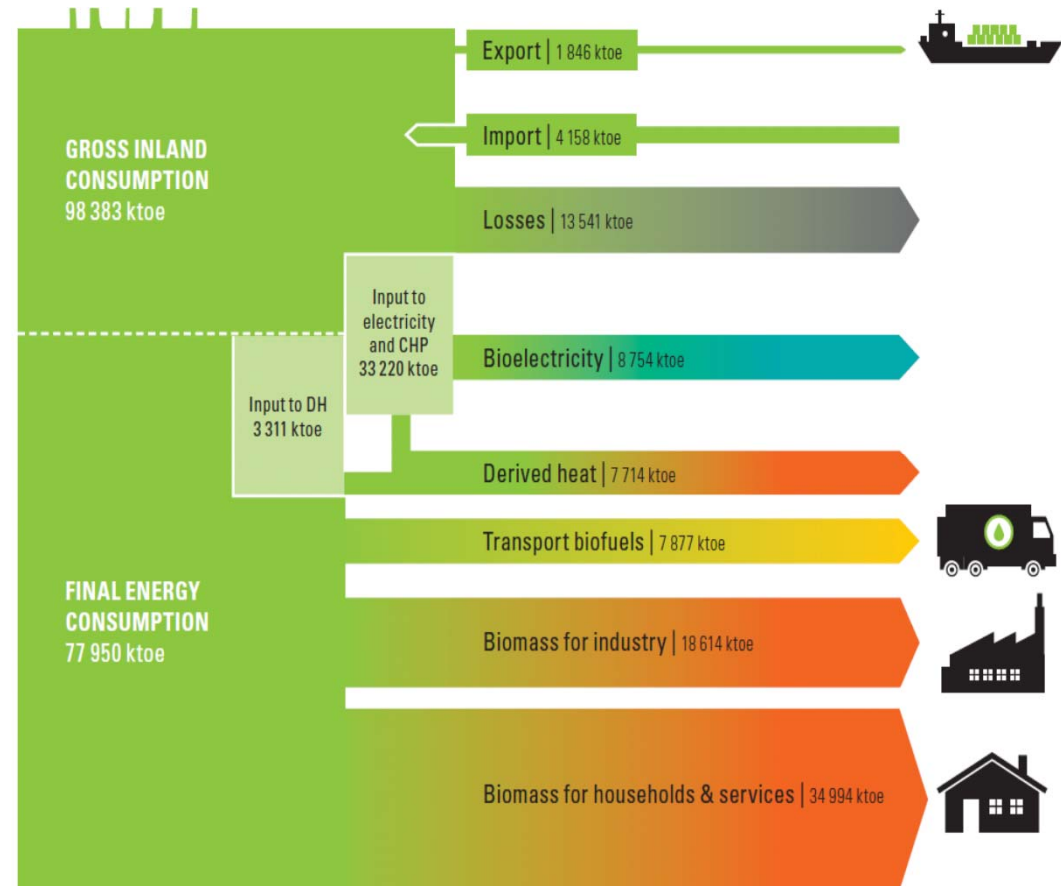
Methods





Background – Bioenergy Market in Europe

- Almost 50% of Biomass used for energetic purposes goes to households (without district heating)
- These are 35Mtoe per anno (2008)
- **More than 80% were used in Stoves!**
- Goal 2020: 70Mtoe p.a.
- **= 400Mio m³ log wood**



Source: Biomass for Heating and Cooling – Visions document, 2010)



Background: Goal 2020 - 400Mio m³ logwood

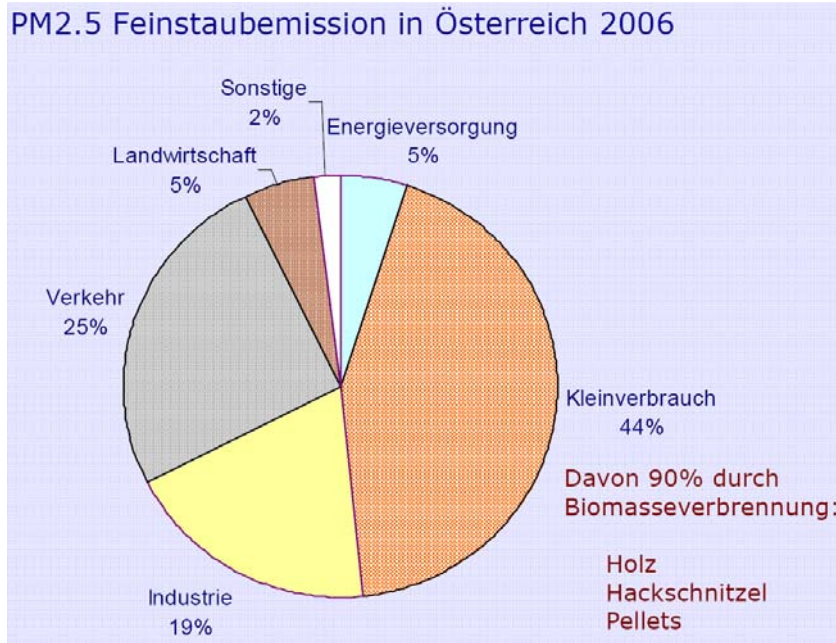
„Stack of wood“



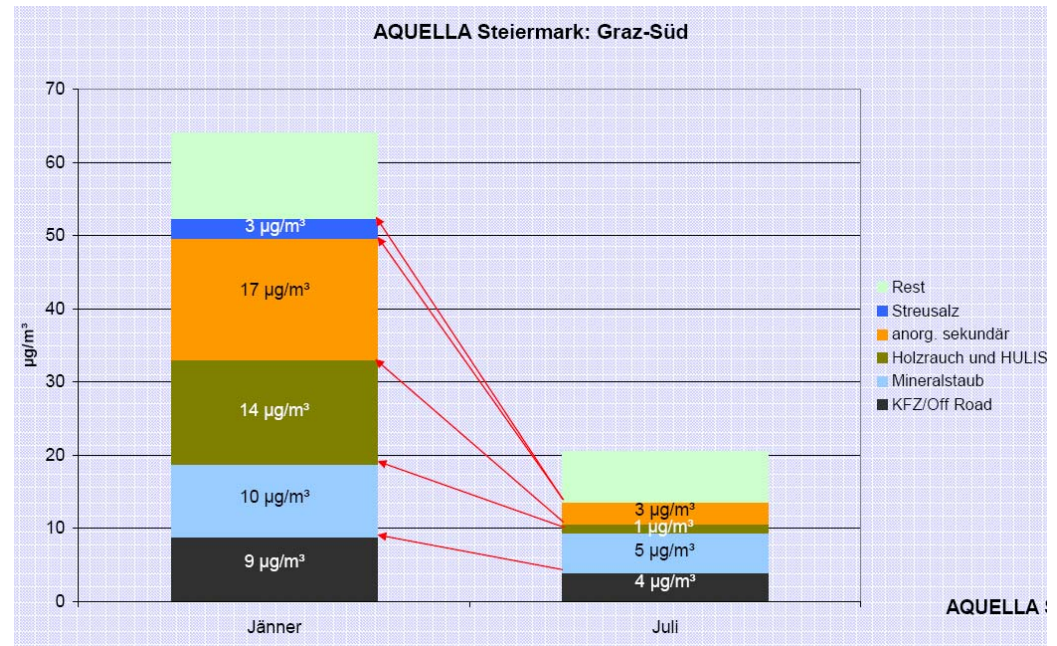


Background – Air quality issues (Austria)

Emission



Ambient (Source Apportionment)



Source: Hans Puxbaum, Vienna University of Technology, Austrian Academy of Sciences



Background – Air quality issues (Europe)

Emission

Schaap et al. 2004:

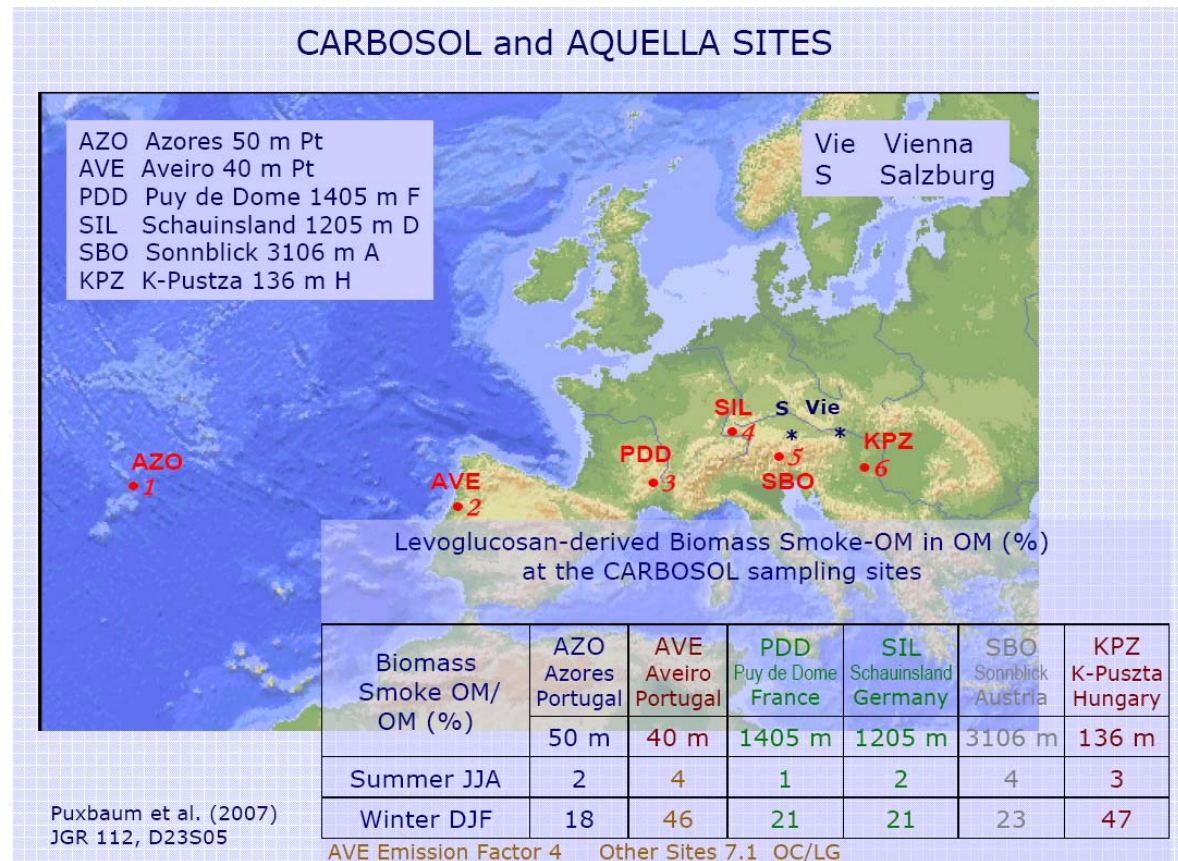
EU Emission Inventory:

- Woodsmoke annual average ~ 25%
- Woodsmoke winter average ~ 45%

... of primary emissions.

→ **20-30% of PM2.5** in winter (source no. 1)

Ambient (Source Apportionment)





Background – currently discussed PM Reduction Measures

- Prohibition of use of biomass stoves in case of air quality threshold exceedances
- Entire ban of logwood stoves from urban regions
- Prohibition of chimney-construction in new buildings (!)
- Solid biofuels exclusively in centralised combustion plants with flue gas cleaning (district heating, CHP) ...

→ **Biomass Heating vs. Air Quality,**

New Stoves 2020 –

trying to initiate the process

of solving this conflict of interest



Basic Project Data

Acronym:

NEW STOVES 2020

Title:

Future Stoves for future houses – Measures for the implementation of the highest possible state of the art of technology of logwood stoves

Project type:

Basic research project funded in the „New Energies 2020“ Initiative of the Austrian Climate- and Energy-fund

Duration:

March 2009 until September 2011

Contact:

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Framework

Which stoves?

Industrial products

- closed fireplaces and stoves
- slow heat release stoves
- kitchen stoves (cooking and baking function)

Which fuels?

Wood in the form of logs

- Log wood (25 cm or 33 cm)
- Wood briquettes



Vision und Goal

VISION

The New Stove 2020 has a strongly positive image among customers and air quality management bodies.

The **NEW STOVE 2020** provides...

- Heat at a highest Level of Comfort and Wellbeing
- highly efficient Use of renewable Energy
- a modern, clean Technology with lowest Emissions

GOAL...

... developing a proposal for a set of measures to push and support a continuous technological improvement of log wood stoves towards a highest possible state,

the **NEW STOVE 2020** .



Target groups and target regions

Target groups are relevant decision-makers...

- from ministries
- from regional legislation)
- from relevant legal bodies
- from relevant standardisation bodies
- from accredited testing bodies
- from relevant associations (chimney sweep, consumerism, ...)
- from lobbying organisations (Austrian biomass association, klima:aktiv, ...)
- from industry (stove manufacturers, chimney manufacturers, ...)
- and customers

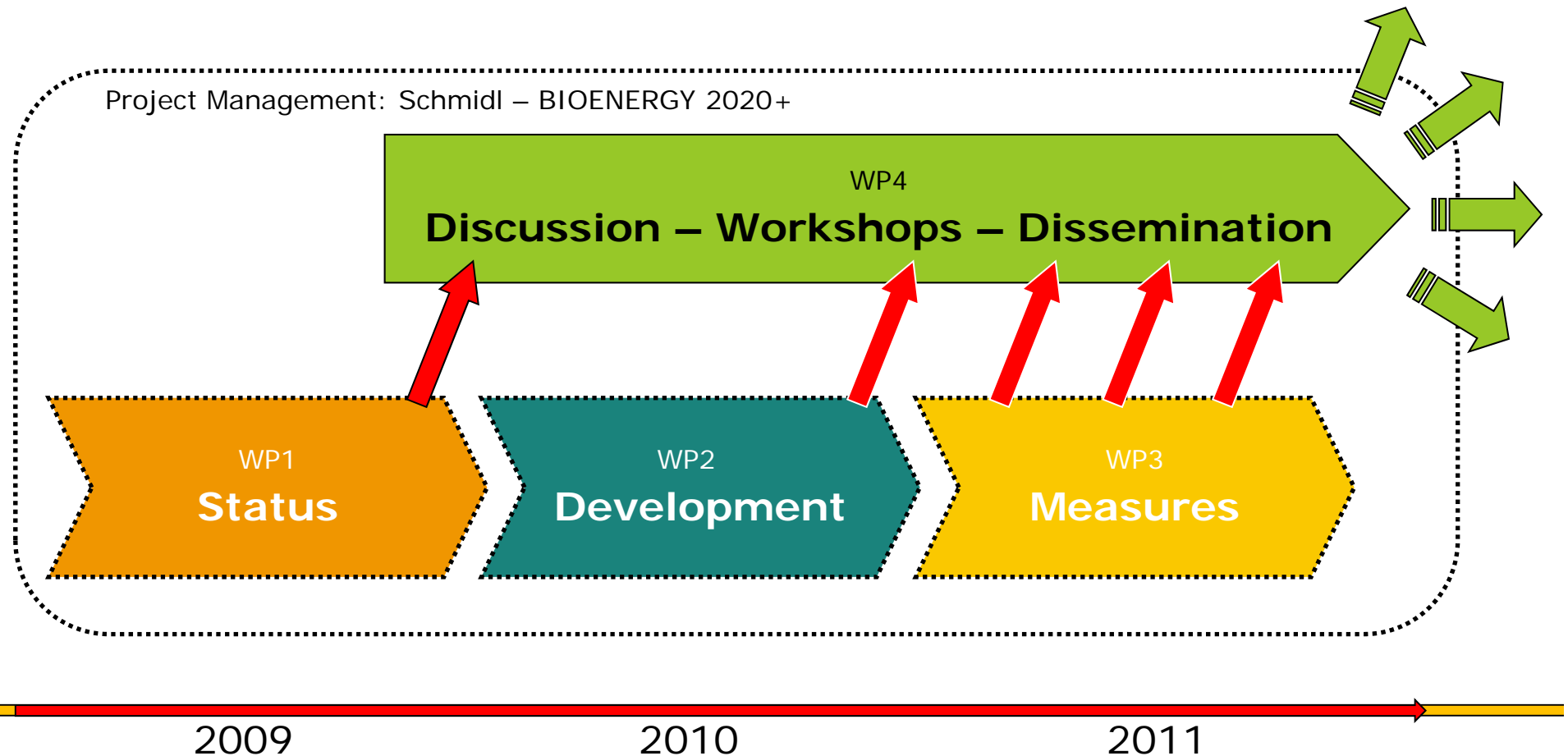
Target regions are:

- Austria
- Germany and Switzerland
- Europe



Project concept and structure

Project Management: Schmidl – BIOENERGY 2020+





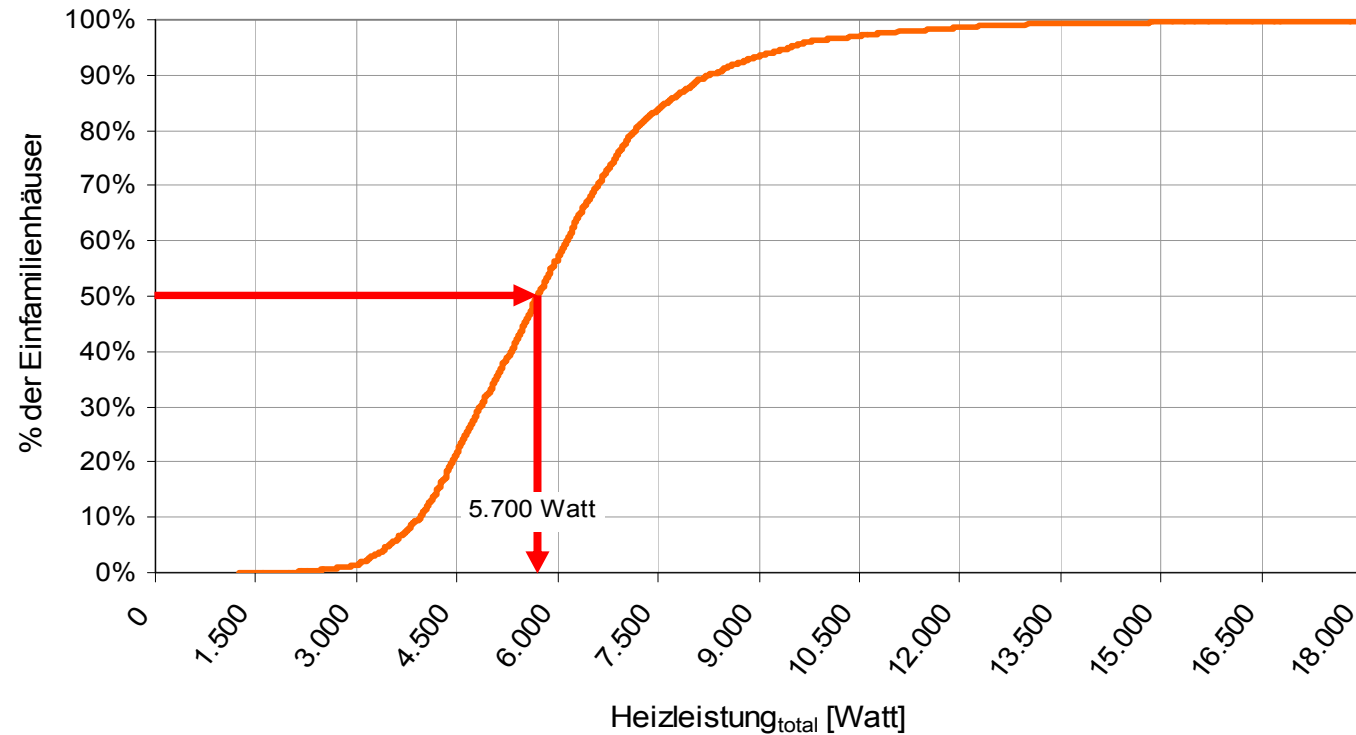
Tasks in WP1 – Status

- Stove market in Austria and Europe
- Regulations and Quality Labels
- Testing standards
- Environmental aspects
- Status-Feedback from relevant Stakeholders
 - Legal bodies
 - Manufacturers
 - Customers
- Status-quo Workshop with main Stakeholders



Outcomes from WP1 - Status

Source: e7 Energiemarktanalyse GmbH, Auswertung der Energieausweise für ein Bundesland 2008 - 2010



→ Stoves could serve as biomass heating systems of the future



Outcomes from WP1 - Status

- Wood stove market is a key factor for reaching European and individual countries' renewable energy goals
- Regulations are getting more stringent, e.g. in Germany (BImSchV) and Austria (15a)
 - but many different thresholds in standards and quality labels,...
- Manufacturers and legal bodies have extremely different positions:
 - Quality of the products
 - Measures for improving air quality situation
- Type testing is criticised from both “sides”



Outcomes from WP1 - Points of view

Air quality regulation bodies:

- Stoves are responsible for high PM levels in winter
- Good type-testing results of new stoves are not considered to be realistic
- Big difference between type-testing and field performance is strongly criticised

Stove manufactureres:

- Air quality regulations harm their market position
- Measures for emission reduction are completely wrong – instead of prohibitions the exchange of old systems should be supported



Tasks in WP2 – Development

- Analysis of primary measures for emission reduction and efficiency increase
 - Air flow / flue gas fan / flow restrictor
 - Combustion chamber design / materials (insulation)
- Analysis of secondary measures for emission reduction and efficiency increase
 - Electrostatic precipitator
 - Ceramic foam
 - Catalysts
- Analysis of testing methods



Emissions – state of the art / best available technology

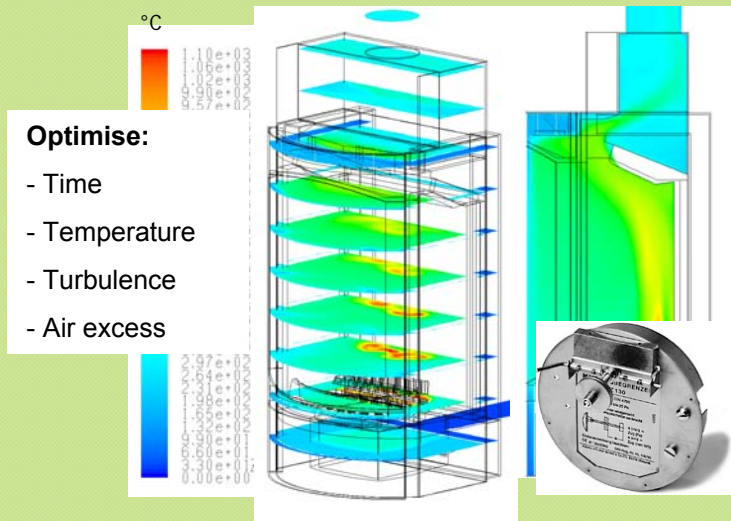
Quellen (EN13240):	§ 15a B-VG	Environmental Label	State of the Art: Average of positive tested stoves (n=33)	Best available technology Minimum * values of 33 tested stoves
CO [mg/MJ]	1100	700	703	276
OGC [mg/MJ]	80	50	46	16
Dust [mg/MJ]	60	30	28	10

* Minimum values for each parameter



Development Guideline

1) Primary Measures



= Optimising primary combustion conditions

2) Secondary Measures

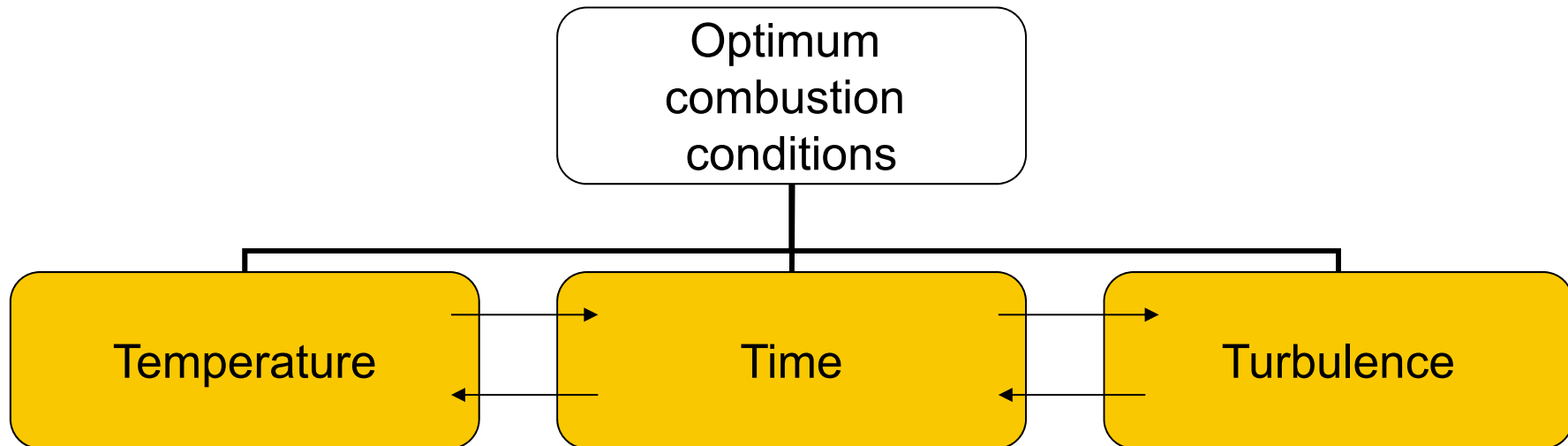


= Flue gas cleaning

3) Consider effects of secondary measures on primary conditions



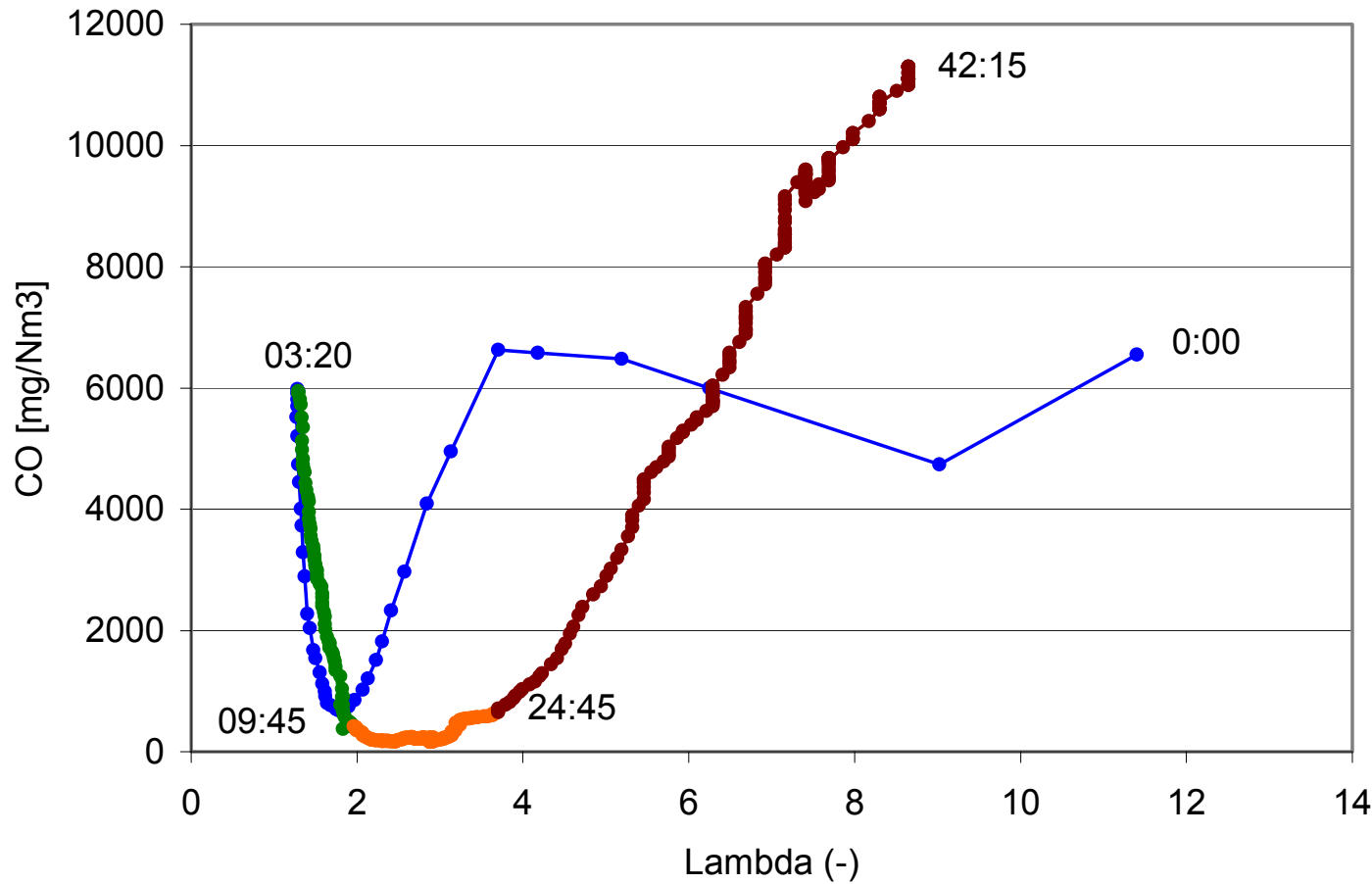
Overview Primary Measures



- | | | |
|---------------------------------|------------------------------|--------------------------------------|
| → Insulation | → Size of combustion chamber | → Air staging |
| → Low air excess | → Air flow | → Installations for flow disturbance |
| → pre-heating of combustion air | → Burn-out chamber | → Sufficient combustion air supply |



Primary measures: CO-Lambda



Local lack of oxygen

Optimum conditions

Temperature too low

- Start
- Bereich 1
- Bereich 2
- Bereich 3



Development example: Logwood stove (6kW)

Logwood Stove	Referenz	Primary Measures			Secondary Measure
		Optimierung I	Optimierung I + II	Optimierung I + II + III	Optimierung I + II + III + Kat
Änderungen		neue Strömungsführung	Luftaufteilung und Zugplatte	Umlenkung	Oxidationskatalysator
CO ₂ [%]	8,1	8,1	7,9	8,4	8,5
CO [mg/MJ]	842	678	518	417	107
Emissionsminderung		-19 %	-39 %	-51 %	-87 %

Measurement according to EN 13240!



Type testing (EN13240) issues

- Testing procedure description gives space for interpretations
 - E.g. Start/End of measurements
 - Some testing institutes even stretch the given space for interpretations
- Type-testing to field-performance factors are high
 - Start-phase not considered
 - No consecutive burn cycles necessary
 - Influence of user is not considered
- Type – testing results do not allow a distinction between high quality and low quality products in terms of environmental impact
 - *“...with enough time I can test almost every stove to comply with the standard... there is no limit of failed tests...”*
- No systematic inspection if tested systems = sold systems

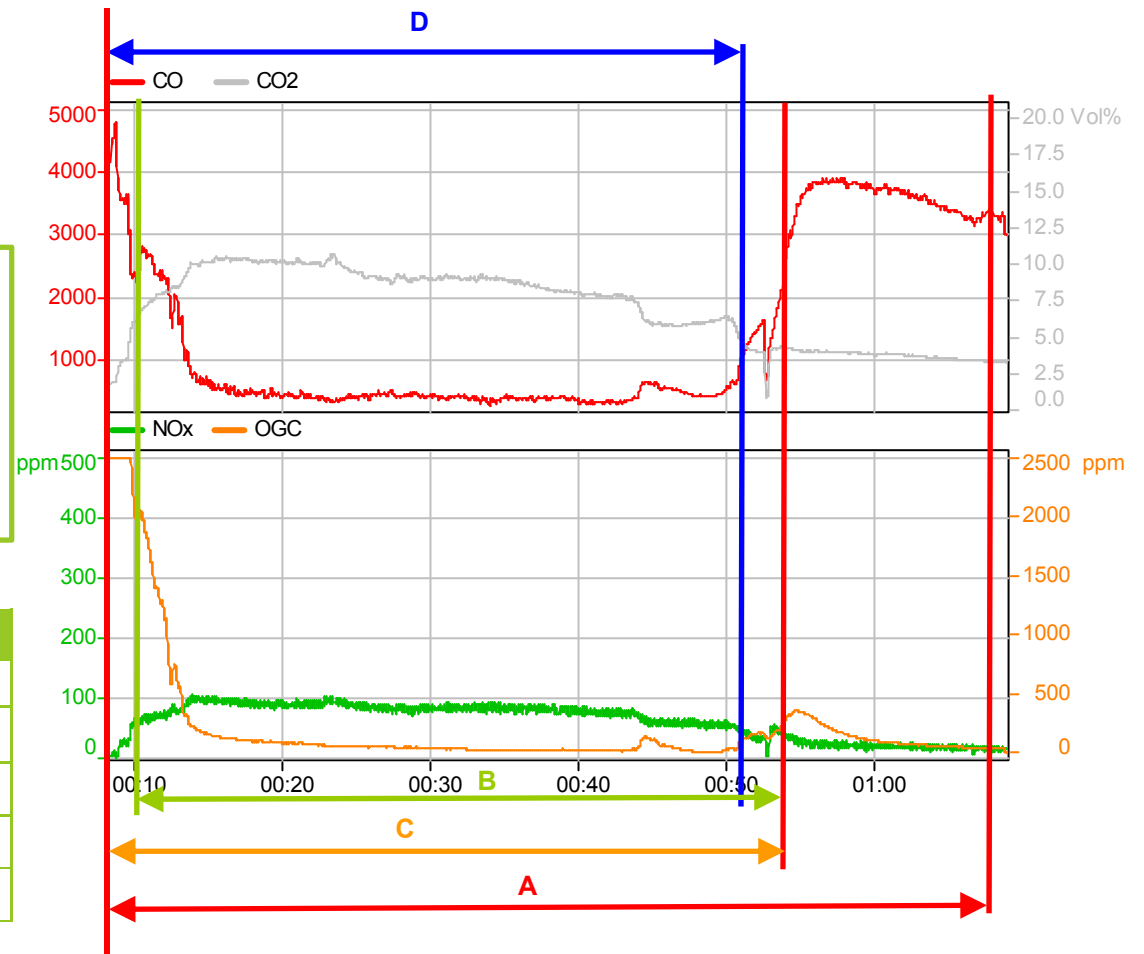


Stove type-testing (EN13240)

Typical stove test according to EN13240, four examples of „data analysis“:

- A – incl. start-phase until equal weight + ash
- B – no start-phase 4% CO₂ until 4 % CO₂
- C – incl. start-phase until 4% CO₂
- D – incl. start-phase until no visible flames

Interval	CO ₂	CO	NO _x	OGC	η [-]
	[%]	[mg/MJ]	[mg/MJ]	[mg/MJ]	
A	7,0	1177	99	83	72,4
B	8,0	586	104	27	74,4
C	7,8	751	104	22	74,2
D	8,3	546	106	22	75,5





WP3 - Measures

- Series of workshops with stakeholders to develop a strategy for measures
- Try to “change” sides:
 - What can manufacturers offer to air quality legislation bodies?
 - Further development (in the right direction)
 - Tested systems = sold systems
 - What can legal bodies offer to manufacturers?
 - Adapt thresholds if necessary
 - Support changeout of old appliances
- Which measures are needed?
 - A new testing method: **Stove testing 2020**



Outcomes from WP3 - Measures

- Develop a new testing method for room heating appliances
 - Based on existing EN13240
 - Close to “real-life” operation
 - New quality assurance method (centralised, automated data analysis)
- Propose threshold values according to the new test method (if necessary)
- Manufacturers participate in “Stove testing 2020” project and increase development efforts towards improvement of field performance
- Air quality regulation bodies will participate in the follow-up project and consider stove-exchange programmes if testing results are satisfying



Lessons learned...

- Bringing together regulation bodies and manufacturers has been a big success:
 - Time for discussion in workshops very important
 - Each side has to present its own point of view and...
 - ...should also try to understand the “other side”
- Internal workshops with homogeneous groups (e.g. only manufacturers, only testing institutes,...) were used for preparing joint workshops
 - Develop a joint position, but at the same time...
 - ...ask the question: “What can we do to improve the situation?”
- BE2020 as “independent” research institute was accepted as mediator between different stakeholders



Outlook

- Stove testing 2020 project proposal passed evaluation
- Project start: April 2012
- Manufacturers and legal bodies participate
- Method should be available within 2 years
- Manufacturers adapt their technology development towards better field performance
- Legal bodies agreed to support the new method and new appliances tested according to this method (e.g. by subsidies or special permission in air quality sensitive areas)
- Long term aim: Implementation of the new method in a European testing standard



Project consortium

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Project partners



Project sponsors





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Thank you!



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